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(54) IMPROVEMENTS IN OR RELATING TO PYROLYTIC GRAPHITE ARTICLES

(71) We, ENGLISH ELECTRIC VALVE COMPANY LIMITED, a British company, of 106 Waterhouse Lane, Chelmsford, Essex CM1 2QU, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to articles composed of pyrolytic graphite of the kind which are worked from a blank into a desired configuration by means of a shot abrasion or other process. Pyrolytic graphite is a form of molecularly ordered carbon which is produced by vapour deposition resulting from the decomposition of a hot hydrocarbon gas. Although the material is usually referred to as pyrolytic graphite, the material is not a true graphite in the crystallographic sense. The properties of pyrolytic graphite are described in the article "Pyrolytic Graphite" by W.H. Smith, and D.H. Leeds published in Modern Materials, Volume 7, at page 139 et. seq. Academic Press Inc., New York and London 1970. Pyrolytic graphite is a material which is very difficult to work with conventional tools, especially where a perforate article is required and although abrasion techniques have been successfully employed the resulting surface finish is not as good as is desired. For some applications, for example for components to be used at high voltages, surface defects can degrade the performance or life expectancy of the component.

The present invention seeks to provide improved articles composed of pyrolytic graphite and a method of making them.

According to this invention a method of making a perforate article from a laminar blank of pyrolytic graphite includes the steps of machining or abrading selected locations of the blank to produce perforations therein, and thereafter depositing a layer of pyrolytic graphite onto the perforated blank. The term perforation is used to mean a hole passing through the laminar blank.

Usually the thickness of the layer of pyrolytic graphite would be less than the thickness of the blank from which the article is formed.

It is much preferred to use a shot abrasion process to form the perforations, rather than a machining process using, say, a diamond tipped tool.

Where the perforations are formed by directing abrading particles at selected locations of the blank, preferably the thickness of the layer of pyrolytic graphite deposited after said abrading step is comparable to the size of the abrading particles.

The invention is usefully applicable to the making of perforate mesh electrodes for use in, for example, high power transmitting tubes where the properties of pyrolytic graphite allow operation at much higher power levels than would be possible with conventional mesh electrodes.

The layer of pyrolytic graphite which is deposited after the machining or abrasion step has been completed has the effect of smoothing over any jagged or sharp edges and filling in any small pits and apertures that would otherwise impair the operation of the perforate mesh electrode. It will be appreciated that a perforate article such as a mesh electrode has an extremely large number of edges where pits and spikes may appear. In high power electronic transmitting tubes, for example, high potential fields are present between the perforate mesh electrode and neighbouring electrodes during operation and the presence of sharp edges, spikes and the like can initiate voltage breakdown. For satisfactory operation voltage breakdown must be avoided. The benefits of providing the layer are not of course restricted to mesh electrodes, since it is preferred to have a perforate article with

smooth contours rather than one with a pitted surface and jagged edges, even though, hitherto, the existence of these surface defects may not have been appreciated.

The invention is further described, by way of example with reference to the drawings accompanying the Provisional Specification in which:

Figure 1 illustrates a mesh electrode in accordance with the present invention and

Figure 2 illustrates part of a section taken through the mesh electrode.

The difficulties of working pyrolytic graphite are well known. It is a brittle material and very liable to splinter and chip if machined by conventional methods such as drilling or milling and the like. The use of abrasion to work and shape the material takes advantage of the very anisotropic properties of pyrolytic graphite. As is known, pyrolytic graphite is formed by deposition from a hot hydrocarbon gas onto a substrate where a lamina of the material is built up in the form of molecularly oriented layers. The material exhibits a high thermal and electrical conductivity in a direction parallel to the layers, but a very low conduction normal to the layers. The mechanical properties are also very anisotropic; the tensile strength, for example, is many times greater in the direction parallel to the layers than it is normal to the layers. The use of abrasion to work the material takes advantage of this anistropy since abrading particles penetrate fairly readily into and through the layers with little lateral spreading.

A laminar blank of pyrolytic graphite may be produced by the now conventional method of passing a stream of hot hydrocarbon gas, such as methane at 2000°C, over a suitably shaped mandrel.

The elevated temperature causes decomposition of the hydrocarbon gas, and carbon is deposited onto the surface of the mandrel. The method of depositing carbon is described in greater detail in the aforementioned article in Modern Materials Volume 7. Where a laminar blank is to be used to make a hollow cylindrical mesh electrode, the mandrel takes the form of a solid cylinder.

The laminar blank of pyrolytic graphite is then perforated in accordance with a specified pattern. One such perforated mesh electrode is shown in Figure 1. It consists of a hollow cylinder which is closed at its upper end and which is open at its lower end. Each perforation is typically one or two millimetres wide and about the same dimension in length and is produced by abrading the blank with, for example, alumina particles in accordance with a predetermined geometrical pattern using a marking template. The particle size is not critical, but one typical size is 29 microns.

When the blank has been completely perforated in accordance with the predetermined pattern, it is placed in a suitable furnace and coated with a further layer of pyrolytic graphite by deposition. This further layer smooths out any jagged or sharp edges and fills in minor pits and undesired apertures. The thickness of the further layer is not believed to be critical, but should probably be at least as thick as the size of the abrasive particles used to form the perforations since it is expected that any irregularities would be of a similar order of magnitude. Clearly the layer should not be of excessive thickness or the size of the perforations will be significantly reduced.

Figure 2 shows a sectional view through two perforations formed in the cylindrical wall of the mesh electrode. The inner portion 1 represents the original material forming part of the laminar blank. The outer layer 2 represents the further layer of pyrolytic graphite which is deposited to smooth out the surface irregularities.

WHAT WE CLAIM IS:—

1. A method of making a perforate article from a laminar blank of pyrolytic graphite including the steps of machining or abrading selected locations of the blank to produce perforations therein, and thereafter depositing a layer of pyrolytic graphite onto the perforated blank.

2. A method as claimed in claim 1 wherein a shot abrasion process is used to form the perforations.

3. A method as claimed in claim 1 or 2 wherein the thickness of the layer of pyrolytic graphite is less than the thickness of the blank from which the article is formed.

4. A method as claimed in claim 2 wherein the thickness of the deposited layer of pyrolytic graphite is comparable to the size of the abrading particles.

5. An article of pyrolytic graphite made in accordance with any of the preceding claims.

6. A perforate mesh electrode made in accordance with any of claims 1 to 4.

7. A perforate mesh electrode substantially as illustrated in, and described with reference to the drawings accompanying the Provisional Specification.

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1456462 PROVISIONAL SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale

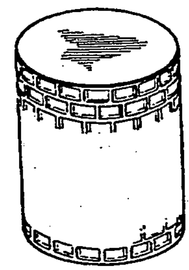

FIG. 1.

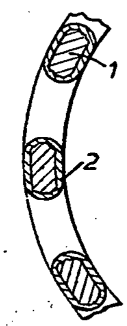

FIG. 2.